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THE EDUCATIONAL VALUE OF A UNIVERSITY NATURAL HISTORY MUSEUM[1]

IN President Rea's address before the 1920 meeting of the museums association it is stated that 38 per cent. of the 600 museums of the United States are supported by colleges and universities, and that of this number but five expended $1,000 or more in the year 1910. It is also stated that of this 38 per cent. the great majority are uncared for or ill cared for. With a few notable exceptions this statement is true of the natural history museums of 90 per cent. of the colleges and universities.

The reason for this deplorable condition is not hard to find. A generation or two ago the study of natural history, or "natural theology," centered about collections of natural history material—corals, shells, fossils, minerals, birds, etc.—and taxonomy was considered the *summum bonum* of science. As time passed, the wonderful discoveries in genetics, in evolution, in experimental biology, gradually superseded the previous systematic studies, museum specimens were used less and less, and finally, in many colleges, ceased altogether. The museums were nominally under the charge of a professor of zoology or geology, who gave little time to the care of the material. The collections in these colleges have thus gradually gone from bad to worse, and in many cases the perishable material is now of little or no value.

An instance is recalled that in one museum in a large university a collection of kangaroos had been received and stored in a room on the upper floor of a building, where they remained for a number of years. When examined it was found that moth larvae had eaten away the bases of the hairs and the whole back came off like a blanket when touched. This entire collection was thus completely ruined because of lack of funds to provide a tight case and some one to care for the material. In another university a valuable collection of insects had to be destroyed because of its infestation with dermestes. These examples could probably be duplicated many times.

What, then, is the remedy for this distressing condition which renders so large a percentage of our university and college museums ineffectual and a re-

[1] Contribution from the Museum of Natural History, University of Illinois, No. 30. Read before the American Association of Museums, May, 1922.

proach to the profession? The remedy seems plain—the organization of a separate museum department under the charge of a trained curator in every university and college. Is this possible? I think it is, largely. It is a question of convincing the administrative officers that such a step would materially advance the value of the college in its undergraduate as well as its graduate work. This missionary work must largely be carried on by the American Association of Museums. Think what a powerful impetus would be given to the museum movement if 75 per cent. of the 38 per cent. now ineffective could become effective departments of the institutions in which they now but occupy room probably needed for class rooms.

The problem that first presents itself to one seeking to energize these old museums is, "How can I convince the president or trustees that the museum is of vital importance?" For the question put at once to the enthusiastic museum supporter will be, "Of what value is this material to the curriculum of this college?" And this is but a fair question which we ourselves must answer convincingly. Are the methods in use in the modern public museum of value also in a purely educational institution like the college?

Having had a wide experience of some twenty-odd years as curator of a public museum in a large city and also an experience of some seven years in two universities, the writer feels that he can speak with some degree of authority on this subject. With some modifications, made necessary by the change from a public museum to a university museum, the methods in use in a modern public museum are admirably adapted, even necessary, for use in a college museum, large or small. I wish, in the few moments at my disposal, to indicate concretely how a university museum should develop in order that it may be of value and importance to an educational institution of this kind.

These are the days in which visual education is being preached far and wide. The museum has been a pioneer in the field of visual education, and the big city museum is to-day the best single factor in education through the eye. There is scarcely a subject taught in a college that can not be very materially aided or rendered clearer by a carefully planned and executed exhibit. Sir Edward Flower's epigram that the value of museum exhibits depends largely on the method of their exhibition and the use made of them for the purpose of education is so fundamental that it should be considered one of the basic laws of museum administration.

In order that I may be specific let me outline a few exhibits that are or might be in almost daily use in undergraduate classes. A course in systematic zoology is rendered intelligible only by reference to a well-organized synoptic collection, arranged to show the leading types of the animal kingdom from simple to complex organisms, with an abundance of descriptive labels outlining in more or less simple language the general characters that distinguish one group from another, interesting notes on evolution, distribution or economic use. Maps, diagrams and other illustrative matter should be liberally used. The subjects of evolution, distribution and development can be admirably illustrated by museum exhibits.

Ecology, the modern natural history, can be made both interesting and intelligible by habitat groups, which need not be expensive to be effective. The invertebrates lend themselves more readily to the preparation of habitat characteristics because more profoundly affected by external conditions, and many small vertebrates can be added, so that fundamental principles can be expounded at less expense than by the large and more expensive habitat groups. The group idea is admirably adapted for the presentation of problems in agriculture. These may be of a monographic character, showing, for example, the principal insects affecting corn, grass, fruit, etc. Three such groups at the University of Illinois—corn insects, apple insects, insects in winter—have been found of value to entomology students as well as to the farmers and agriculturists who take short courses in the college of agriculture. A case of local birds is an organic part of a course in ornithology, and during the time of the course students may be seen studying the specimens at different times every day. This exhibit is an integral part of the university curriculum.

Historical geology or paleontology can not be well understood by the undergraduate student without the aid of a well-organized stratigraphic collection in which he may see the actual organic remains described and figured in his text-book arranged in cases in proper relation to each geological period, beginning with the oldest, where he may follow the changes that have taken place during the long period of time since life first made its appearance on the earth. Here he may see a type of animal or plant rise, decline and become extinct, to be followed by another type, often quite different from the first type. In my own museum, half of a large hall is to be devoted to this subject next fall, because so urgently needed.

In modern geography, the museum can be of the utmost value, for here, by the use of models and specially prepared exhibits, the common things of life from all countries may be shown in such a manner as to indicate clearly the relation of various raw materials to present civilization. Thus cotton, steel, rope, paper, buttons, aluminum, petroleum and many other commodities may be graphically exhibited so that the different processes of manufacture may be indicated. Models of physiographic geology may also

be added and will aid in showing how a group of peoples have taken advantage of geographic conditions to aid their social and economic development. Ethnology is but a branch of geography, and by the aid of small groups and actual material the different races or tribes of a country may be made to live again in the imagination. To the college of commeree these exhibits will also prove of value.

The foregoing relates only to the material exhibited in the public halls—the undergraduate side of the museum. But there is another side which must be considered by a strong university—the research or graduate side. Such an institution should accumulate in an accessible manner large series of groups of animals, plants, geological material, etc., for the use of graduate students and for working scientists, both among the faculty and in outside institutions. In this department valuable collections that have formed the basis for formal papers may be carefully preserved for future study. Such material should be cared for by installation in compact drawer cases contained in study rooms away from the museum halls. These collections provide the scientific standing of a university museum.

The question will naturally be asked, Whether the average college can do this? I think it can. Many colleges, of course, are handicapped by lack of funds, and to these the establishment of an adequate museum would be impossible. But there are many colleges and universities in which this department can be established, or, if already established, made stronger. In many cases, public-spirited citizens of wealth would gladly help such a movement if the college museum could be open to the general public and its collections made attractive. I believe that such an arrangement could be made that if the college provided the room, the business men of the town or city would be very willing to bear a large part of the expense of administration of such an enterprise.

I have been asked at different times to indicate the kind of man that is best suited to successfully administer such a department, especially in a college of moderate resources. A curator for this department should, of course, be a man of good education (not necessarily with a doctorate), but above all he should be capable of using both head and hands, with inventive ability, resourceful, and with a pleasing address, working easily in cooperation with other departments. A few such men are available from the ranks of the public museums, but many may have to be especially trained to become college curators.

The items of expense are usually objected to when the subject of a new department is suggested. This need not be great. A good salary for the curator, plus $2,000 per year for development, will accomplish wonders if the curator is of the right sort. Much may be done on less, and greater results will follow larger resources. It would seem possible to establish the kind of museum outlined above in all our larger universities with a relatively small expenditure of money. It is being done at Illinois, and also in some other state universities, and should be in others.

My experience of five years at the University of Illinois has shown conclusively that a modern working museum is a highly desirable part of a large university and that the methods in use in our great public museums are in the main applicable to the needs of the university museum. Most universities are far removed from the large city museum and can not enjoy their privileges. In a university situated as is the University of Illinois, in a small community far removed from the great metropolis, such a place as a museum becomes of wide significance, providing not only material aid for the curriculum but also a place for healthful recreation where the entire student body may go and unconsciously gain knowledge of the great world about them, much of which will be second in importance only to the regular courses they may be taking. It is my purpose at the University of Illinois to show that a natural history museum can be one of the most potent factors in general education.

FRANK COLLINS BAKER
NATURAL HISTORY MUSEUM,
UNIVERSITY OF ILLINOIS

AMPHIOXUS FISHERIES NEAR THE UNIVERSITY OF AMOY, CHINA

THIS note is to announce the discovery of an apparently inexhaustible supply of amphioxus near the University of Amoy. The ease with which these zoologically important little animals are to be obtained here should make them available in practically unlimited quantities for students of biology the world over. It has been my privilege recently to visit the village of Liuwutien,[1] about six miles from the University of Amoy, the source of livelihood of whose inhabitants is the amphioxus fisheries, to make a preliminary investigation of the methods employed in their capture and, as a fitting climax, to partake of a luncheon, several dishes of which consisted in main or in part of amphioxus.

The term fisheries as applied to the capture of amphioxus will no doubt seem strange to zoologists, not so much because amphioxus is not a fish as because of the impression we tend to gather that it has not been found, hitherto at least, in sufficient numbers

[1] Lakotiam in the local dialect.

to justify the use of the term, nor systematically taken for food or other economic purposes. We are most of us wont to see a few specimens at a time, carefully preserved from the rude hands of students. Or, if we have had the experience of dredging for them, as I did some ten years ago in the Philippine Islands, we remember the rejoicings over a few rare specimens obtained. In the present instance, however, because of the great numbers caught and their systematic capture for food purposes, it seems necessary, for lack of a better term, to speak of the industry as the amphioxus fisheries.

So far as I have been able to determine, the industry is as old as the village of Liuwutien, at least several hundred years old—so old that the mind of man runs not to the contrary. The amphioxus fisheries are confined, apparently, to a narrow strip of sea bottom less than a mile wide and extending for about six miles along the coast of the mainland of the Province of Fùkien, South China, immediately behind, *i.e.*, to the north of the Island of Amoy, on which is located the treaty port of the same name and the recently organized University of Amoy. This fishing ground is separated from the island by a narrow strait noted for its strong tidal currents which probably have something to do with making this particular stretch of sea bottom especially favorable for the life of amphioxus.

Here on this little strip of coast about 400 fishermen, using 200 small boats, are engaged for from two to four hours on the ebb tide of every calm day during the nine months from August to April of each year in dredging for amphioxus for the market. The catch per boat is said to average about 10 catties (13 1/3 pounds) a day, while double that amount is taken on especially favorable days. This means a catch of about 2,600 pounds, well over a ton for each calm day during the nine months of the fishing season and a total of hundreds of tons of amphioxus taken during the year!

The larger individuals average about three grains in weight. As a considerable number are under weight an estimate of 2,500 to the pound seems conservative. Counting the number of fishing days as 200 per year and the average daily catch per boat as 13 pounds we arrive at the astonishing total of 6,500,000 individuals in the average daily catch and 1,300,000,000 in the average annual catch. Making deductions for boats out of service, etc., we must conclude that on this little strip of Chinese coast somewhere around a billion amphioxi are caught and consumed each year. If we consider the inefficient and unsystematic method of fishing and the unfailing supply we are led to the conclusion that this strip of sea bottom must harbor many billions of the little animals.

The area to which we are told the amphioxi are limited extends out as far as two li, about 3/5 of a mile, and along the coast for about 20 li, approximately six miles. The actual area of sea bottom involved will be seen to be very considerable, in proportion to the part actually taken up in the dredging operations, particularly, since, so far as we know, the fishing is conducted in a very unsystematic manner, the boats working, much of the time, over more or less the same ground. When, in addition to these facts, we take it into consideration that there is never any failure to obtain the organisms in normal quantities we are forced to believe that the number actually taken is so negligible in proportion to the countless billions present as to make extremely improbable any danger of diminution of their numbers as a result of the industry as now conducted.

If, however, the local fishing rights are weakened and the number of fishermen increased, and more effective and systematic methods of fishing employed, as may well be the case in the future, the fact that gamete-laden amphioxi have such a gritty and unpleasantly fishy taste as to make them quite unpalatable during the spawning season of May, June and July may become an important factor in the preservation of the industry.

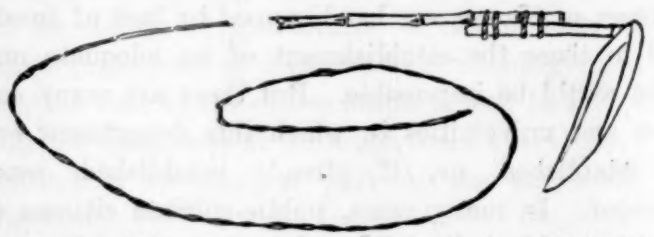

FIG. 1. Dredging apparatus used in the amphioxus fisheries at Amoy, China

The fishing methods and the apparatus used in the local capture of amphioxi while rather primitive are fairly effective. There are two men to each boat, one who sculls and one who manipulates the dredging apparatus. This consists of what appears to be a scoop-shovel blade attached at less than a right angle to a long bamboo (see Fig. 1). To the end of the bamboo is fastened a cable made by twining together two long rattans, to which is spliced another similar cable, the whole reaching a length of from 30 to 50 feet. The dredger stands in the bow of the boat and when fishing grounds are reached, usually in water from two to four fathoms in depth, the dredge is lowered with the blade downwards. When it is resting on the sand the boatman sculls the boat backward for a short distance to bury the blade in the sand. He then sends the boat slowly ahead while the dredger draws in the cable and passes it over the bow of the boat until the bamboo is reached or the apparatus is in a nearly vertical position when it is gently drawn upward and lifted out. The sand brought up on the

blade is dumped into the boat and the operation repeated until a considerable amount of sand containing amphioxi is obtained, when the boat puts for shore to separate the animals from the sand. This is accomplished in shallow water by means of deep, rounded baskets of split bamboo which are whirled about and shaken until most of the sand is washed out through the interstices. The remaining sand, with the amphioxi, is then removed to a much broader and very shallow basket where the final separation is accomplished by the continuation of the process until the animals can be floated off and the remaining coarse sand flipped over the edge.

The inhabitants of the region near the fisheries prize the amphioxus as a dainty. The people of other regions are more or less repelled by its unfamiliar appearance, and hence the greater part of the catch is consumed locally. Emigrants from the locality living in Malaysia purchase a considerable amount of the dried product. The fresh animals remain in an active condition for 12 hours or more after being removed from the water and are available for food for 24 hours or more. They are tender and wholesome and when fresh have a very palatable flavor. No ill effects of any kind are known to follow their use. The economic and social changes now in progress in China will almost certainly result in an increased demand for amphioxus for food purposes. Before any considerable increase in the extent of the industry will be possible the local fishing rights which at present make the industry a regional monopoly must be weakened and of course any such increase would be limited by the actual available supply of the animals which is problematical as yet but seems at least great enough to allow for a very material increase in the catch without appreciably diminishing the supply.

The dried product is prepared by heating the amphioxi after thorough washing in fresh water to drive out the excess salt water, after which they are roasted over a slow fire with a small amount of oil until dehydrated. In this form they are very palatable and keep for several months in the winter and a month or more during the summer. The fresh animals sell for 15 cents Mexican and the dried product for a dollar Mexican in the local markets.

The data given here were obtained for me on our trip of investigation by Dr. Lim Boon Keng, president of the University of Amoy, who kindly questioned the fishermen and other inhabitants and made translation of their answers. Numerous other interesting questions arise as to habits, habitat, structure, physiology and development of this species, some of which I hope to be able to answer in the future. Among these are the actual distribution of the amphioxus in depth and along the coast, and their food, the tidal currents and any other factors which explain their presence in such numbers in this one locality.

It may be of interest to relate here the curious belief of the local inhabitants to account for the presence of these organisms in such numbers at this spot and nowhere else. The name of the lancelet in Chinese is Wen Shen Yü,[2] which being literally translated means "fish of the God of literature" or more idiomatically, "literary composition fish." It is also called "silver spear fish"[3] from its color and its resemblance in shape to the Chinese spear blade and also "carrying pole fish" from its fancied resemblance to the carrying pole of this part of the world which is flattened and tapers towards both ends. The prevalent name, however, is the one first given, which is derived in the following curious manner. The God of Literature of Chinese mythology, named Wen Shen, who was supposed to aid the competitor in the civil service examinations in the classics, at present superseded but at one time all important in China, is supposed to ride about upon the back of a crocodile and is often so pictured. Now, as the story goes, the crocodile of Wen Shen died and the dead body washed ashore and is clearly to be seen only a short distance from the village of Liuwutien in the form of an island known as Crocodile Island,[4] some white rocks at one end of which may be conceived by a stretch of the imagination to be the snout, the wooded portion in the center, the body, and a long sand spit, exposed at low tide, the tail. From this, the carcass of Wen Shen's crocodile, issue the worms or maggots, the amphioxi. And since, forsooth, this is the only dead crocodile of the region there are of course no amphioxi found elsewhere. Lest this may appear to be the strained explanation of some of the local literati allow me to relate my experience with an ignorant boatman while attempting to obtain the animals by dredging just off the sandy beach in front of the University of Amoy, some six miles in a straight line, but more than twice that by water from the seat of the amphioxus fisheries. The boatman whose sampan we hired for the attempt was very curious as to what we were doing and when my Chinese collector explained he threw up his hands in disgust and could hardly be prevented from at once rowing to shore, saying in great contempt for our ignorance of a matter of such common knowledge, "There is no use wasting your time looking for that fish here since there is no crocodile here."

As to the systematic position of the species under consideration I am unable to make any final statement

[2] Wen Shen Yü, locally pronounced *Boon Shiong Hee.*

[3] Yin Chien Yü.

[4] Pien Tan Yü.

in the absence of the necessary literature. That it is a species of the genus *Branchiostoma* seems probable, since the gonads are paired and the metapleural folds meet symmetrically behind the atriopore. It differs from *Amphioxus lanceolatus* as described in the literature at present available to me in several particulars, most strikingly in the presence of somewhere near 25 pairs of oral tentacles or cirri (Fig. 2). Whether or not it is the *Branchiostoma belcheri* reported from Singapore to Japan I am unable to determine, having no description of that species at hand.[5]

I am sending specimens with this note to Professor E. G. Conklin, of Princeton University, with the request that he have it determined and if possible publish the name of the species with this note for the information of zoologists.

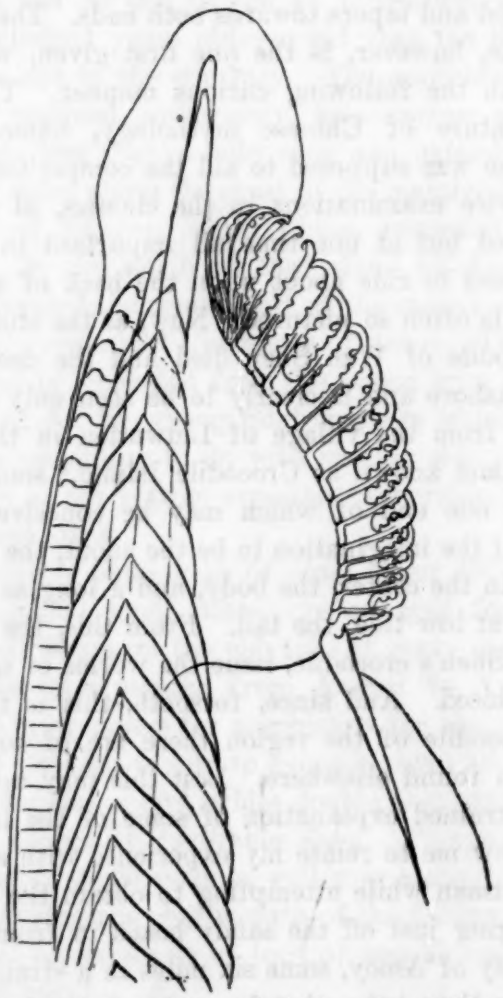

FIG. 2. Anterior portion of body of amphioxus from Amoy showing about 20 oral cirri of the right side, x Ca. 34

[5] Mr. J. T. Illick has examined some of the specimens sent me by Professor Light and finds that there are:

20 ± pairs of cirri
20 ± pairs of gonads (not well developed)
65 ± Myotomes of which 39 are anterior to the atriopore, 17 are between the atriopore and anus, and 9 are post-anal.

He concludes that this species is probably *B. nakagawae*, or *B. belcheri* and these may be identical. (See Cambridge Natural History, Vol. 7, p. 138.) A later note from Professor Light informs me that the species is probably a new one, which he is now engaged in describing—E. G. Conklin.

The outline drawing of the anterior end of one of the animals discussed in this note and the diagram of the dredging apparatus used in their capture were very kindly made for me by Mr. E. Larsen of the Chinese Postal Service, the former being a tracing from a detailed drawing he is making of the anterior region of a specimen slightly under an inch in length and the latter being a diagram from the apparatus as shown in several photographs which were taken for me on the fishing grounds by Professor H. H. Chung in charge of the department of botany in the University of Amoy.

S. F. LIGHT
PROFESSOR OF ZOOLOGY,
UNIVERSITY OF AMOY

SEVENTH YEAR OF THE TROPICAL RESEARCH STATION OF THE NEW YORK ZOOLOGICAL SOCIETY

THE Tropical Research Station of the New York Zoological Society was founded in January, 1916, after many conferences of Henry Fairfield Osborn, Theodore Roosevelt, Madison Grant and William Beebe. The site chosen was the district immediately around Bartica, British Guiana, in typical tropical rain forest, sixty-five miles from the coast and at an elevation of only twenty-five feet. The station itself is at Kartabo, at the point of junction of the Cuyuni and Mazaruni Rivers, where intensive research work has been carried on in a quarter of a square mile of jungle and shore.

Under the directorship of William Beebe, five expeditions have been made into this field. There have been thirty-two months of actual work, covering every season of the year. Research work at the station has been carried on by twenty-eight workers from America, England, Scotland and France, and two hundred and forty-six visitors have been entertained. One hundred and forty-one contributions have been published, including four bound volumes.

From the limited area under intensive research there have been collected notes, materials and specimens as follows: (1) Life history notes on 75 species of mammals, 451 species of birds, 108 species of reptiles and amphibians, 130 species of fishes; (2) nests and eggs of 152 species of birds, many new to science; (3) skins, skulls and skeletons of 56 species and 650 individual mammals; (4) 1,550 bird skins; (5) 110 bird embryos; (6) hundreds of reptiles, amphibians and fish; (7) 85,000 insects, of which one item is types of 50 new species of termites; (8) 4,500 other invertebrates; (9) 550 KOH specimens;

(10) 2,022 photographic negatives; (11) 22,000 feet of motion picture film; (12) specimens have been supplied to seven universities and five museums, while of living vertebrates there have been collected and sent to the New York Zoological Park 40 mammals, 207 birds and 119 reptiles; (13) the chief collections of amphibians, reptiles and mammals have been presented to the American Museum of Natural History.

It is interesting, in view of this successful prosecution of research work in the tropics, to consider the actual cost of the entire undertaking. From the beginning to the present time the total income has been $49,600. This has included the salary of the director, his assistant and chief artist, the steamship fares, entire scientific outfit, boats, tents, bungalow, household expenses, servants, hunters, taxidermists and the general accommodation for the staff of workers. The five expeditions have averaged six and a half months each, with an average of eight staff members, the total average cost of each trip being $9,920.

The Galapagos Islands

The seventh expedition of the Department of Tropical Research of the New York Zoological Society was directed to the Galapagos Archipelago, and is known as the Williams Galapagos Expedition. Through the generosity of Mr. Harrison Williams the two hundred and fifty foot steam yacht *Noma* was chartered for the purpose and left March first on a cruise of two and a half months under the direction of William Beebe. The personnel of the party included the regular staff of the Tropical Research Station, Misses Cooper and Rose, Messrs. Tee-Van and Broking, Mr. Hoffman, marine artist, and Mr. Escherich, taxidermist. Four guests of Mr. Williams, Messrs. Curtis, McKay, Mitchell and Merriam, assisted in making collections. Professor William Morton Wheeler joined the vessel at Panama and will contribute to the scientific reports.

A total distance of nine thousand miles was steamed, and the equator crossed eight times. Twenty-one days were spent on the Galapagos Islands. To the living collections of the New York Zoological Park were added nine mammals, twenty-seven birds, and forty-two lizards, notable among which were flightless cormorants, Galapagos penguins and hawks, and giant marine and land iguanas peculiar to the Archipelago and never before exhibited alive. For the American Museum there was collected material for two lizard groups, *Amblyrhynchus* and *Conolophus*, including vegetation, rocks, shells, photographs and sketches, together with a giant tortoise, eighteen lizards and a family of sea-lions.

Among other material gathered were 90 water colors, 400 photographs, 11,000 feet of moving picture film and many thousands of vertebrates and invertebrates. These will be studied by various specialists, while the general account of the trip by William Beebe will be published this autumn in book form by G. P. Putnam's Sons, under the auspices of the Zoological Society.

HENRY FAIRFIELD OSBORN,
President of the Zoological Society

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Plans for the Seventy-fifth Anniversary Meeting

MEMBERS of the local committee for the approaching Cincinnati meeting of the American Association for the Advancement of Science and members of its subcommittees have been named as follows:

Louis T. More, chairman of the Local Committee.
Thomas Quinlan, Subcommittee on Hotels and Transportation.
E. D. Gilman and L. T. More, Subcommittee on Meeting Places.
R. E. Oesper, Subcommittee on Exhibits.
N. M. Fenneman, Subcommittee on General Program.
C. N. Moore and W. H. Bucher, Subcommittee on Publicity.
George Warrington, Subcommittee on Hospitality and Receptions.
H. S. Fry, Subcommittee on Dinners and Society Hotel Headquarters.
E. D. Gilman, Secretary of the Local Committee.
Daniel Laurence, Treasurer of the Local Committee.

Preparations for the meeting are going forward in a very satisfactory way and a very good set of arrangements for serving the various sections and societies has been worked out. The following local representatives for the sections have been named:

Section A, Louis Brand.
Section B, S. J. M. Allen.
Section C, H. S. Fry.
Section D, E. I. Yowell.
Section E, O. C. von Schlichten.
Section F, E. C. Day.
Section G, H. M. Benedict.
Section H, H. McE. Knower.
Section I, B. B. Breese.
Section K, E. E. Eubank.
Section L, E. M. Lostpeich.
Section M, R. S. Tour.
Section N, Henry Page.
Section O, Wendell Paddock.
Section Q, A. L. Hall-Quest.

Each section representative is to act for the special societies in his field and all inquiries and requests concerning sessions, meeting places, etc., from the societies, as well as from section organizations, should

be made directly to the proper section representative or representatives. If societies have named special local representatives other than the local representatives of their section, these special society representatives should consult with the proper section representative in all cases. It is not necessary, however, that the special societies that are to take part in the Cincinnati meeting should name special local representatives. The attention of the secretaries of sections and societies is especially called to this arrangement, which promises to avoid some of the confusion that has sometimes occurred in the preliminary work for past annual meetings.

The Hotel Sinton is to be the general headquarters hotel for the association as a whole. This hotel has promised exceptionally good features and offers attractive prices. It will be able to accommodate a large number of those who will attend the meeting. All rooms are provided with bath and the prices are to be $3.00–$5.00 per day for single rooms and $5.00–$7.00 per day for double rooms. Headquarters hotels for the several societies are to be arranged for through the local representatives for the proper sections. The Hotel Sinton can accommodate a number of societies and there are other excellent hotels in Cincinnati from among which society headquarters may be selected. Society officers should correspond with their section representative in this regard, as well as in regard to arrangements for sessions. The same plan also applies to arrangements for society dinners and smokers.

The section representatives, who will have charge of all details for the sections and societies, will be in constant and direct communication with the subcommittees and with the general local committee itself, and information of all kinds may be secured by writing to the proper section representative. These representatives and the members of the local committee and its subcommittees are to be addressed in care of the chairman of the local committee, Dr. Louis T. More, University of Cincinnati, Cincinnati, Ohio.

The privilege of reduced railway rates for the Cincinnati meeting has been granted for most of the country, according to the certificate plan, which has been in operation at recent annual meetings. Those going to Cincinnati are to purchase regular one-way tickets and are to secure from the railway agent, when tickets are purchased, one-way certificates properly filled out by the agent. These certificates, upon being properly endorsed and validated in the registration room, will allow their holders to purchase return tickets at one half of the regular rates. Those residing in the Pacific region will this year have this privilege, which has not been available to them for recent meetings.

All sessions of the third Cincinnati meeting will be held in the buildings of the University of Cincinnati and of the Hughes High School, which is situated adjacent to the campus. The council of the association will hold its main meeting on the afternoon of Thursday, December 27, and the meeting will be opened on the evening of that day, under the presidency of Dr. Charles D. Walcott, secretary of the Smithsonian Institution. The main address at this session will be given by the retiring president of the association, Dr. J. Playfair McMurrich, professor of anatomy in the University of Toronto. The second annual Sigma Xi lecture will be delivered on Friday evening, December 28, under the joint auspices of the Society of Sigma Xi and the American Association for the Advancement of Science. The speaker will be Dr. Willis R. Whitney, of the General Electric Company.

The Cincinnati meeting will be specially interesting and important on account of its being the seventy-fifth anniversary of the founding of the association. One of the evening sessions will probably be devoted to the development of American science during the three quarters of a century since the founding of the association. Further details will be announced from time to time in the pages of SCIENCE, and the preliminary announcement of the meeting will be mailed about December 1 to all whose names occur on the association roll at that time.

BURTON E. LIVINGSTON,
Permanent Secretary

SCIENTIFIC EVENTS

MAGNETIC OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE

SPECIAL magnetic and allied observations will be made at stations inside and outside the shadow belt of the total solar eclipse of September 10, 1923, by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, and by various cooperating magnetic observatories, institutions and investigators.

The magnetic observatories, either within or near the limits of the eclipse, are: *North of the belt of totality,* Sitka, Alaska; Meanook, Alberta; Tucson, Arizona; Agincourt, Ontario; Cheltenham, Maryland, and Vieques, Porto Rico; *to the south of the belt of totality,* Honolulu, Hawaii; Cuajimalpa, Mexico, and Huancayo, Peru; *while just outside the limits of the eclipse at beginning and ending* are Kakioka, Japan, and La Quiaca, Argentina. Of the observatories, the one at Tucson is particularly well situated, being only about 200 miles from the central path of the eclipse; the maximum obscuration at Tucson will be about 92 per cent. It is planned that the Department of Terrestrial Magnetism will have parties at two stations within the belt of totality to make magnetic and

atmospheric-electric observations, one of these stations being where the Mt. Wilson Observatory party will be located. The United States Coast and Geodetic Survey will have one special party for making magnetic observations within the belt of totality in southern California, and special observations will be carried out at its observatories. It is also hoped that some magnetic and allied observations may be made at a mountain station, for example, Mt. Wilson, where the maximum obscuration will be about 98 per cent.

The general directions of work proposed by the Department of Terrestrial Magnetism, especially with reference to magnetic and atmospheric-electric observations, as also recording forms, will be supplied to any one interested.

LOUIS A. BAUER
J. A. FLEMING
DEPARTMENT OF TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION OF WASHINGTON

RUSSIAN BIOLOGICAL INSTITUTES

Apropos of the list of then-existing biological institutes compiled by H. J. Muller during a trip to Moscow and Petrograd in August, 1922, the following information received from Dr. W. Grossmann, of the Permanent Bureau of the All-Russian Entomo-Phytopathological Congress, Petrograd, may add to our meager knowledge as to the now-existing natural history societies in Russia. In reply to a letter containing a list of Russian corresponding societies of the Academy of Natural Sciences of Philadelphia, Dr. Grossmann wrote, under date of December 24, 1922, that the societies listed below exist "up to the present time," and states that "their names are the same," only the word "Imperial" must be omitted where formerly used.

Moscow. Société des Amis d'Histoire Naturelle.
" Moskovskoe Obstchestvo Estestvo-Ispytateley.
Petrograd. Russian Academy of Sciences.
" Botanitcheski Ssad.
" Comité Géologique.
" Musée Géologique de l'Université.
" Russkoe entomologitscheskoe Obstchestvo.
" Société Russe de Géographie.
" Mineralogitcheskoe Obstchestvo.
" Tsentralnaia Fizitcheskaia Observatoria.
" University.
Tiflis. Botanical Gardens.
" Musée du Caucase.

Dr. Grossman regrets his inability to send some Russian publications on entomology, "as our formalities of censorship are very complicated and postal charges very high." I am sure we all agree with Dr. Grossmann's concluding paragraph, "Let us hope that in some not too distant future the circumstances will change for the better."

WM. J. FOX
THE ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA

PALEONTOLOGICAL FINDS IN MORAVIA

SINCE the constitution of Czechoslovakia as an independent state, intensive work has been carried on, principally under the auspices of the Provincial Museum at Brno (Brünn), in the great system of limestone caverns of Central Moravia. These caverns disclose not only a great wealth and beauty of stalactitic and stalagmitic forms, but they have also yielded to date numerous indications of the presence of early man, and many skeletal remains of diluvial mammals, some of which are in an excellent state of preservation. These remains now include skeletons of a mammoth, of two lions, of a hyena, a Gulo-borealis, five cave bears and no less than sixty fossil beavers. The skeletons of the cave bears are practically complete and will soon form a striking group in the museum. The preservation of the beavers' skulls and teeth is perfect and the series is one of great value.

The work of exploration of these caves, new ramifications of which are being discovered every year, proceeds under the energetic direction of Dr. Karel Absolon, Curator of the Brno Museum.

A. HRDLICKA

NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

THE Board of National Research Fellowships in the Biological Sciences met on June 30 and made the following appointments in addition to those reported in a previous number of SCIENCE:[1]

Herbert Friedmann, Zoology
E. F. Hopkins, Botany
A. A. Roback, Psychology
F. B. Wann, Botany
Alexander Weinstein, Zoology

These fellowships are supported by a contribution of the Rockefeller Foundation and are administered by a special Board of National Research Fellowships in the Biological Sciences, appointed by the National Research Council. The fellowships are open to citizens of the United States and Canada who possess a Ph.D. or its equivalent. They are intended for candidates in the earlier years of post-doctorate work, and are designed to recruit men and women as leaders of research in the universities and research establishments of the United States and Canada.

[1] May 18, 1923, p. 579.

The basic stipends awarded are $1,800 for unmarried fellows and $2,300 for married fellows per annum. These stipends may be increased when there are other dependents or for other cogent reasons.

The fellowships are not granted to any institution or university, but the choice of place to work is left to the fellow, subject to the approval of the Fellowship Board. The appointments are for full time and no other remunerative or routine work is permitted, except that during the college year the fellows may, by written permission of the board, give a portion of their time, in general not more than one fifth (outside preparation included), to teaching of educational value to themselves, or to attendance on advanced courses of study.

The particular individual with whom a fellow wishes to work should, ordinarily, have agreed to accept him, prior to the consideration of his application by the board. It is further required that the fellow be charged no fees or tuition by the institution where he chooses to work.

When the board will next meet has not yet been decided. A meeting in the spring of the year is assured and if the number of applications received justify it, other meetings will be held in the interim accordingly. Applications may be received at any time and will be placed on file for the meeting which follows their receipt. Requests for information and application forms should be addressed to the Secretary, Board of National Research Fellowships in the Biological Sciences, 1701 Massachusetts Avenue, Washington, D. C.

F. R. LILLIE

CHAIRMAN OF THE COMMITTEE ON BIOLOGY AND AGRICULTURE OF THE NATIONAL RESEARCH COUNCIL

SCIENTIFIC APPOINTMENTS IN THE BUREAU OF MINES

WITH the advancement of Dr. S. C. Lind, formerly superintendent of the Rare and Precious Metals Experiment Station, at Reno, Nevada, to the post of Chief Chemist and Chief of the Division of Mineral Technology to succeed Dr. R. B. Moore, other changes in the research branch of the Bureau of Mines throughout the country were made. E. S. Leaver, formerly superintendent of the Southwest Experiment Station, Tucson, Arizona, was selected to succeed Dr. Lind as superintendent of the station at Reno. Mr. Leaver was designated as Dr. Lind's successor because of having given his attention for a great many years to problems connected with the metallurgical treatment of the western ores, especially those associated with the cyanide process.

S. P. Howell, formerly of the Pittsburgh Station, who has spent the past year in Arizona studying the mining problems of that State, especially regarding the use of explosives, has been designated as superintendent of the station at Tucson.

During the past year G. St. J. Perrott and S. P. Kinney have conducted an intensive study of the combustibility of coke in blast furnaces. This work will hereafter be conducted by Mr. Kinney in connection with the operation of the experimental blast furnace at the North Central Experiment Station, Minneapolis, and at commercial furnaces in South Chicago, Illinois, and Youngstown, Ohio. Mr. Perrott has been transferred to the Pittsburgh Experiment Station to direct chemical-physical work in connection with the liquid oxygen explosives investigations.

Dr. T. T. Read, formerly chief of the division of information service in the Washington Office, has been transferred to Duluth, Minn., and made superintendent of the North Central Experiment Station. The headquarters of Dr. Read were fixed at Duluth to permit of maintaining a closer contact with the mining phase of the work.

T. L. Joseph has been made assistant superintendent of the North Central Experiment Station at Minneapolis.

Oscar Lee has been transferred from Minneapolis to the Southern Experiment Station, Tuscaloosa, Alabama, and placed in charge of the iron ore beneficiation work under the direction of Dr. W. R. Crane, superintendent of the station.

Dr. W. D. Bonner, who has been employed as a physical chemist at the Pacific Experiment Station, Berkeley, California, has resigned and will return to the University of Utah as an instructor. C. G. Maier, formerly with the department of metallurgical research of the University of Utah, has been appointed to the position at Berkeley made vacant by Dr. Bonner's resignation.

Professor Ernest A. Hersam, of the University of California, who for the past year has studied metallurgical milling problems at the Massachusetts Institute of Technology in cooperation with that institute and with the American Institute of Mining and Metallurgical Engineers, has returned to his former position as an instructor at the University of California.

John Gross, of the station at Reno, Nevada, will go to Cambridge to continue the work which Professor Hersam has been doing.

John Blizard, who has had charge of the Bureau's fuel work at its Pittsburgh Station, has resigned to accept a position with a commercial concern in New York City, where he will be engaged on the design of super-heaters and heat transfer apparatus.

SCIENTIFIC NOTES AND NEWS

DR. A. A. NOYES, director of chemical research in the California Institute of Technology; Dr. T. W. Richards, professor of chemistry in Harvard University, and Dr. E. B. Wilson, professor of zoology in Columbia University, have been elected foreign honorary fellows of the Royal Society of Edinburgh.

DR. C. F. CHANDLER, professor emeritus in Columbia University, has been elected an honorary member of the Society of Chemical Industry, of which he is a past president.

PROFESSOR JOHN MERLE COULTER, head of the Department of Botany at the University of Chicago, has been elected an honorary fellow of the Botanical Society of Edinburgh.

THE University of Strasbourg has conferred on Dr. Jacques Loeb, member of the Rockefeller Institute for Medical Research, the title of doctor *honoris causa* of the university.

PROFESSOR A. EINSTEIN has been elected a member of the Prussian order "Pour le mérite."

DR. L. H. BAEKELAND, of Yonkers, N. Y., honorary professor of chemical engineering in Columbia University, has been made "Officier de la Legion d'Honneur" by the French Republic. Dr. Baekeland is president of the Bakelite Corporation and of the General Bakelite Company and past-president of the American Institute of Chemical Engineers and of the American Electrochemical Society.

PROFESSOR PITRES, neurologist and former dean of the Bordeaux faculty of medicine, has been elected a member of the Paris Academy of Moral and Political Sciences.

DR. R. H. TODD and Dr. W. T. Hayward are the first recipients of a gold medal instituted by the British Medical Association in Australia for "distinguished service." It is to be presented at the congress of the association to be held in Melbourne in November.

DR. EMMANUEL DE MARGERIE, director of the geological map service of Alsace and Lorraine, who has spent several months in the United States, returned to France on the steamship *Paris*, which sailed on July 7.

THE twenty-fifth anniversary of the graduation of Professor F. A. H. Schreinemakers in the University of Leyden on July 7 is being marked by the issue of a special number of the *Recueil des travaux chimiques des Pays-Bas* which will contain more than sixty articles in English, French, German and Italian by colleagues, pupils and friends.

DR. MELVILLE T. COOK, professor of plant pathology at Rutgers College, has accepted an appointment as expert on diseases of sugar-cane at the Insular Experiment Station at Rio Piedras, Porto Rico. Dr. Cook was plant pathologist for the Cuban government from 1904 to 1906.

DR. LELAND E. COFER, of New York City, has been appointed director of the division of industrial hygiene of the State Department of Labor. Dr. Cofer has been an officer in the United States Public Health Service for over thirty years and has served two terms as assistant surgeon general of the United States, a position he was filling when he was assigned by the United States Public Health Service as health officer of the port of New York.

DR. HAROLD HIBBERT, associate professor of applied chemistry at Yale University, is in England and expects to visit cellulose chemists in Europe.

PROFESSOR LESTER W. SHARP, who has been granted sabbatic leave of absence from the department of botany at Cornell University for the first semester of the coming academic year, will spend the late summer and autumn in northern Europe, chiefly at the Universities of Stockholm, Copenhagen and Louvain. He left Ithaca late in July and will return in November.

DR. JOHN A. MILLER, vice-president of Swarthmore College and head of the Sproul Observatory, left on July 13 with several other scientists to observe a total eclipse of the sun on September 10 from a mountain station in Yerbaniz, Mexico. Other members of the expedition include Professor R. W. Merriott and Professor W. R. Wright, of Swarthmore College.

DR. B. KEREKJARTS, formerly of the University of Budapest and last year a lecturer at Göttingen, will be a lecturer in mathematics at Princeton University during the next academic year.

WE learn from *Nature* that at a meeting of the Royal Society of New South Wales, on May 2, the following officers for 1923–24 were elected: *President,* Mr. R. H. Cambage; *Vice-Presidents,* Professor C. E. Fawsitt, Mr. J. Nangle, Mr. E. C. Andrews and Mr. C. A. Sussmilch; *Hon. Treasurer,* Professor H. G. Chapman; *Hon. Secretaries,* Professor O. U. Vonwiller and Mr. G. A. Waterhouse; *Members of Council,* Dr. C. Anderson, Sir Edgeworth David, Mr. W. S. Dun, Dr. R. Greig Smith, Mr. Charles Hedley, Rev. E. F. Pigot, Mr. W. Poole, Mr. H. G. Smith, Professor J. Douglas Stewart and Professor R. D. Watt.

THE *British Medical Journal* reports that a president's gold chain and badge have been presented to the Royal Society of Tropical Medicine and Hygiene by the retiring president, Sir James Cantlie, who was

one of its founders. The chain consists of a number of plaques held together by ornamental links. Each plaque bears, or will bear, the name of a former president. The center link is formed by the initials of the donor surrounded by a laurel wreath. The badge shows a sketch of a mosquito on a shield, with the motto *Zonae torridae tutamen*. The incoming president, Sir Percy Bassett-Smith, was formally invested with the chain by the retiring president at the last meeting of the society.

PROFESSOR F. GOWLAND HOPKINS, Cameron prizeman for 1922 at the University of Edinburgh, delivered two lectures on June 27 and 28, respectively, on the present position of the vitamin question. The Cameron prize, which was founded in 1878, is awarded annually to an investigator who in the course of the five years immediately preceding has made an important addition to practical therapeutics.

DR. STEPHEN SHELDON COLVIN, professor of education at Teachers College, Columbia University, a leader in educational psychology, died suddenly on June 15 at the age of fifty-four years.

THE Board of Estimate of the City of New York has unanimously voted to erect a school service building four stories in height, which is to be placed in the west courtyard of the American Museum of Natural History, at an estimated cost of $733,000. It will include a basement, fully equipped for the distribution of educational material to schools and will be connected by a subway with all other sections of the museum. The basement is also planned to take care of visiting classes that come from a distance from out of town schools. The first floor is designed for the general subject of the natural history of man, showing the relation of man to his environment; also for public health and food exhibitions, including a memorial alcove to Louis Pasteur. The center of this floor is designed for normal school work. The third and fourth floors are designed for practical normal school and college instruction in smaller rooms and for the preparation of the photographic and museum materials which make the round of the schools. The city was moved to make this appropriation by the rapid increase in the use of the museum by the schools, which now reaches four million pupils annually, a figure equivalent to five contacts with each of the 900,000 children now enrolled in the schools of Greater New York.

ACCORDING to the London *Times* the British Medical Association has purchased the premises in Tavistock Square, Bloomsbury, known as the Theosophical College. It is a modern building, designed by Sir Edwin Lutyens, whose plans were never fully completed, as the building was taken over by the government at one time. It is understood to be the intention of the British Medical Association, for whom Mr. J. A. Phillips (Oxford street) acted as agent, to enlarge and adapt the building as their headquarters. Tavistock Square, on the east side of Gordon Square, has changed in character, like all the Bloomsbury squares in recent years, from being purely residential, and in its early days it had many distinguished literary and other residents, among them Charles Dickens. The neighboring Russell Square has become mainly a center of professional and other organizations, one of the first to settle in that square having been the Auctioneers' and Estate Agents' Institute, now about to transfer its headquarters to a new building in Lincoln's Inn fields. If the project for placing the headquarters of the University of London on "the land behind the British Museum" matures there will be a further aggregation of societies in that district.

THE *Geographical Journal* writes: "An undertaking of considerable interest has been organized by the newly founded Scientific Expeditionary Research Association in the form of a scientific expedition to the Pacific, which will leave Plymouth towards the end of September. Free passages will be provided for students of the various branches of science in which investigations are desirable, their expenses being covered in large part by receipts from paying guests, for about twenty of whom there will be room in the vessel chartered—the *St. George*, a three-masted barquantine fitted on the lines of a yacht, with 800 h.p. auxiliary steam engines. It is proposed to use the Panama Canal route both going and returning, and to include in the itinerary the Galapagos, Easter and Pitcairn islands, the Austral and Cook groups, Tahiti and the Marquesas, with various intermediate islands. Although the scientific objects of the expedition may perhaps be hampered to some extent by the need to consider the requirements of the non-scientific members, the project seems to offer an excellent opportunity to young men who have just qualified in the various branches of science to acquire experience and first-hand knowledge of remote parts of the world, otherwise not easily accessible to study.

FROM a report in the *Journal* of the American Medical Association we learn that at the sixth session of the League of Nations health committee, at Paris, May 26, the development of inter-governmental cooperation in public health matters was discussed as regards epidemiologic intelligence and public health statistics, a regular and rapid method for distributing information has been installed. Three committees were formed: the first, to investigate the prevalence of epidemic (lethargic) encephalitis and tuberculosis in tropical Africa since the World War; the second, to investigate the quantity of opium and other habit-

forming drugs required annually by the various nations for legitimate purposes, and the third to collect information for a conference among various European states having navigable inland waterways, for the purpose of coordinating and strengthening sanitary control, without interfering with the normal functions of the waterways. A report was made of research work conducted in laboratories scattered all over the world during the last eighteen months, aiming at an international standardization of serums. A similar program was proposed in regard to insulin, digitalis and pituitary extract. Public health courses are being conducted for public health officials in Warsaw, Kharkov and Moscow under the auspices of the health organization of the league, and, by an arrangement with the Soviet Russian delegation at the Genoa conference, the members of the health committee, together with a delegate from the central health authorities of Soviet Russia, constitute a special international commission for discussing the anti-epidemic campaign as it affects Russia.

THE Hancock Life Insurance Company, Boston, has made an additional gift of $20,000 to the Harvard Cancer Commission; $5,000 to be used for purchase and installation of a diagnostic apparatus and $15,000 to be placed in the permanent fund. The insurance company previously gave $30,000 toward the building of the Huntington Hospital, which is devoted exclusively to cancer cases. The new gift will be used in the biophysical laboratory, which is also under the direction of the commission.

THE Langenbeck-Virchow Haus, built for the headquarters of the German Surgical Society and the Berlin Medical Society, has been rented to the Siemens and Halske firm for a period of ten years, with the provision that the societies shall continue to have the use of the building for meetings.

DR. KLEIWEG DE ZWAAN, of the University of Amsterdam, has instituted a triennial prize of 2,500 francs to be awarded for research in anthropology.

UNIVERSITY AND EDUCATIONAL NOTES

MRS. NORMAN BRIDGE, wife of Dr. Norman Bridge, professor emeritus of Rush Medical College, has subscribed $100,000 to the fund provided by Mr. Frederick H. Rawson for the Rawson Memorial Laboratory to be built in connection with the medical work of the University of Chicago on the West Side of Chicago. The fund donated by Mrs. Bridge will be used to provide the Norman Bridge Pathological Laboratories which are to occupy the fifth floor of the Rawson Memorial Laboratory.

DR. GEORGE SCATCHARD, associate professor of chemistry at Amherst College, has resigned, being the tenth Amherst college teacher and the fourth alumnus of the college to withdraw from the faculty because of the dismissal of Dr. Meiklejohn. Professor Scatchard explains his resignation in the following statement to President Olds: "After the loss which the college has sustained, it no longer seems possible to accomplish here the purposes for which I came to Amherst."

AT the University of Chicago, Dr. Harvey Carr has been promoted to a professorship of psychology; Dr. Arno Benedict Luckhardt to a professorship in physiology, and Dr. Fred Conrad Koch to a professorship in physiological chemistry.

DR. JOSEPH W. ELLIS, formerly of the University of California at Berkeley, has been appointed instructor in physics in the University of California, Southern Branch.

PROFESSOR JOHN SMITH DEXTER has been appointed associate professor of biology at the University of Porto Rico.

DR. THOMAS JONES MACKIE, professor of bacteriology at the University of Capetown, has been appointed Robert Irvine professor of bacteriology in succession to the late Professor James Ritchie.

DR. P. J. DANIELL has been appointed to the Town Trust chair of mathematics at the University of Sheffield.

DISCUSSION AND CORRESPONDENCE

NOTE REGARDING THE ANNUAL VARIATION OF ATMOSPHERIC POTENTIAL-GRADIENT

MY attention has been called to Dr. Sanford's article in SCIENCE of May 25, 1923, pages 616–618, in which he attempts to account theoretically for the annual variation of the atmospheric potential-gradient. Every student of atmospheric electricity will welcome any suggestion for the solution of some of the outstanding questions of atmospheric electricity, but evidently Dr. Sanford did not have before him the latest observational facts, and so his theory is based on erroneous premises.

In connection with various studies during the past two years on the interrelations of terrestrial magnetism and atmospheric electricity, I have had occasion to examine every available series of observations concerning the atmospheric potential-gradient, made during the past 40 years, from the Arctic to the Antarctic regions. A different type of annual variation is found than that premised by Dr. Sanford. The

latter states that "this gradient should accordingly be greater in winter than in summer, and it should vary in some manner with the altitude of the sun." He then attempts to reproduce theoretically the annual variation of the potential gradient, on the basis that it *"must vary as the sine of the angle of the sun's declination from the vertical at any given place."* He accordingly obtains a type of annual variation of the potential gradient varying from place to place, and of opposite character for two corresponding parallels in the temperate zones, north and south, which does not correspond with observational facts. However, it should be noted first that what Dr. Sanford calls in Figs. 1 to 4 the "Solar Declination" is not the sun's declination as used in astronomy, but the *sun's zenith distance* at apparent noon. No curve, the ordinates of which vary with the sine of the sun's declination, would be reversed in passing from the North Hemisphere into the South Hemisphere at the same time of year.

The outstanding fact disclosed by the annual variation of the atmospheric potential-gradient is that it is not chiefly a local but primarily a worldwide phenomenon and, hence, does not vary according to the sine of the sun's zenith distance at apparent noon at any given place. The available data reveal the following general types: Type *a*—from the Arctic regions to about parallel 33° North and from about 40° South to the Antarctic regions, the maximum potential-gradient occurs near the December solstice and the minimum near the June solstice; type *b*—in the region from about 33° North to 40° South, or over about half of the earth's surface in the lower latitudes, the majority of the stations show a reversed annual variation to that of type *a*, hence, maximum potential-gradient near June solstice and minimum near December solstice; type *c*—in region for *b*, or between *a* and *b*, there are certain stations showing a mixed type of *a* and *b*. On the average, from the Arctic to the Antarctic, the annual range of the potential-gradient is about 60 per cent. of the average potential-gradient for the year; the data in the North Hemisphere seemingly indicate that the range decreases as the region for type *b* is approached.

It turns out that Dr. Sanford was so unfortunate as to select for comparison with his computed curve in Fig. 3 a station, Melbourne, Australia, which falls in the region of type chiefly *b*. At a station in greater southerly latitude than Melbourne, for example, at Cape Evans (77°.6 South; 166°.4 East of Greenwich), where Dr. Simpson, while connected with the Scott Antarctic Expedition, obtained a year's series of observations from 1911 to 1912, the same type (*a*) of annual variation of the potential-gradient is found as for a station in the same latitude north. It is accordingly incorrect to describe the annual variation of the potential-gradient as varying with the season. The variation is of the same type at the same time of year in moderate and high latitudes north and south of the equator, namely, the maximum gradient occurring near the December solstice and the minimum gradient near the June solstice.

Dr. Sanford would be unable by his theory to explain the annual variation of the atmospheric potential-gradient at the station, Helwan, Egypt (latitude 29°.9 North; longitude 31°.3 East of Greenwich), where eight years of observations, 1907–1914, show that the minimum gradient occurred in December and the maximum in July. Helwan falls in the region of type *b*; Dr. Sanford's theory would prescribe an annual variation for this station reversed from that actually observed. There are some indications that the bounding parallels between regions of types *a* and *b* will be found to be magnetic parallels, rather than geographic ones.

The main facts of the annual variation of the atmospheric potential-gradient could apparently be explained by a system of vertical electric currents similar to those which are caused by the translatory motion of an electrically-charged sphere through the ether; for example, the charged earth during its orbital motion about the sun. This hypothesis is at present under investigation.

Fortunately, before long we shall have available additional data in the region of reversed type *b*. The Department of Terrestrial Magnetism has at present two observatories which could hardly be more favorably situated for important contributions to our knowledge concerning terrestrial magnetism, atmospheric electricity and earth-currents in equatorial regions; these observatories are: Watheroo, Western Australia (latitude 30°19′ S; longitude 115°53′ E), and Huancayo, Peru (latitude 12°03′ S; longitude 75°20′ W).

LOUIS A. BAUER
DEPARTMENT OF TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION OF WASHINGTON

CASTS VS. CYLINDROIDS

AFTER examining a large number of specimens of casts and mucin from urine under the ordinary microscope and then under the modern dark field microscope (ultra-microscope), it seems to us that dark field examination will probably prove to be a quick and certain method for distinguishing between the two, especially in doubtful cases.

The new method of examination has, so far, revealed marked differences in the ultra-structure of these entities, the mucin showing a faint and extremely fine reticulated ultramicroscopic structure, whereas casts show a much brighter and coarser structure, which is visible even in hyaline casts.

We are continuing this work, and hope to report later, giving photomicrographs, and showing as well the appearance of casts and mucin in the dark field, after they have been acted on by reagents, stains, etc.

JEROME ALEXANDER
JOHN M. CONNOLLY

50 EAST 41ST ST.,
NEW YORK

THE STANDARD POUND

IN the letter of Mr. Alexander McAdie, published in SCIENCE on February 23 ultimo, under the heading "The Depreciation of the Pound," Mr. McAdie states that the provisions of the Corn Sales Act of 1921, effective January 1, 1923, and prescribing that sales of grain, seeds and potatoes in Great Britain shall be by weight only and in terms of the *hundred-weight of 112 pounds*, have the effect of reducing or depreciating the pound from 7,000 to 6,250 grains weight. This is upon the gratuitous assumption that the absolute weight of a hundred pounds or of 700,000 grains is by the Act to be divided into 112 parts to produce a new or "depreciated pound" of 6,250 grains weight. If one were to indulge in assumptions as to the effect of the Act, it would be more legitimate to argue or conclude that the effect of the Act is to divide the absolute weight of 112 pounds or 784,000 grains which constitute the English hundred-weight, into 100 parts to produce an appreciated or enlarged pound of 7,840 grains. But there is neither need nor excuse to indulge in assumptions as to the English *hundred-weight*, because the *hundred-weight*, as specified in the Act of 1921, and as otherwise defined by law, and as long established by custom, consists of 112 standard pounds of 7,000 grains, and is divided into 8 stone of 14 standard pounds. The Act merely declares and confirms the custom of England and establishes uniformity of practice throughout the realm. It imparts nothing new as to the value of the standard pound or as to its division into 7,000 grains, as legally recognized and established in both the United Kingdom and the United States.

The English use and will, under the Act of 1921, continue to use precisely the same pound as the Americans. We, however, use a *hundred* of 100 standard pounds, whereas the English use a *hundred-weight* of 112 pounds. The Englishman wants to divide his *hundred-weight* into 8 equal parts. He can not divide the cental of 100 pounds into 8 equal parts, and he therefore persists in using the *hundred-weight* of 112 pounds, which he can divide into 8 equal parts, each of which he calls a stone. But he nevertheless uses the same standard pound which is used in the commerce of the United States, and certainly no American would deny him the privilege or right to use the *hundred-weight* of 112 pounds, if for reasons which satisfy him, he finds it preferable or convenient to do so, just as the Englishman has no objection to the use of the cental of 100 pounds in Canada, in the British Dominions and in the foreign trade of the Empire.

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APPLIED SCIENCE AND SCIENCE APPLIED

"To be an industrial psychologist one must first of all be a psychologist." "Hardly more than one or two men are earning a livelihood in industry to-day as *psychologists*" (W. V. Bingham). These sentences appear in a modest advertisement of "psychology as a life work" in SCIENCE for April 13.[1] The writer of them believes that "industrial psychology" offers to men with psychological training and possessed of certain assets a career among "fascinating practical problems." The "three outstanding assets for a career" are named by him as "a sound training in scientific method," genuine interest in "all sorts of people and the personality to deal effectively with them," and, finally, "superior practical judgment, especially where money values are concerned." When these assets produce an "output of cash value to industry" they may be expected to bring proportionate "financial rewards." It is exceptional, however—as it appears—for an industrial psychologist to earn a living *as a psychologist*.

In the same article "educational psychology" is declared to show "an increasing demand for experts in psychological and educational measurements." Here "the most necessary qualifications are listed as "general scientific ability, knowledge of educational practice, industry, adaptability and good sense" (E. L. Thorndike). Again, "clinical psychology," which offers to suitable persons opportunities "not surpassed financially," etc., is said to demand acquaintance with the facts of disease and of treatment as well as the "physician's mental attitude" (S. I. Franz). And, in more general terms, "for those who possess the requisite qualities and training there is no limit [in "applied psychology"] to public service and financial rewards" (R. Dodge).

Does this announcement by "experts" persuade the reader that there are "applied psychologies"? Does it not rather call attention to the well-attested fact that scientific knowledge and training may be found to be useful (provided the individual meets certain other requirements) in many practical tasks far removed, in spirit, problem and point of view, from psychology or from any other single science? The article makes it abundantly evident that, where these

[1] SCIENCE, 1923, lvii, no. 1476, pp. 429–431.

tasks relate to such "human endeavors" as medicine, education and business, psychological preparation may be important.

The great public loathes definitions; but it is apt in affixing labels. It has—without any prompting from "science"—stuck the label "psychology" on hypnotism, mind-reading, ghosts, communion with the dead and a dozen magical and medical formulas. From clinical theorists it has eagerly learned to apply the same tag (with "new" prefixed) to the shocking practices of the psychoanalyst. And it has been frequently instructed of late to use the label for various jobs undertaken in business and in the schools by persons whose academic or professional training has included studies of psychology, in tests and in the Pearsonian statistics.

The more seasoned sciences and arts still have their "boundary disputes," but they do not insist that every performance of the scholar or the artisan be set down to the credit of a science or profession. The surgeon skilfully carving the family roast is not doing surgery; nor the zoologist eliminating bad stock from his private herd, zoology; nor the botanist in his lettuce-bed, botany; nor the embryologist, turning an extra penny in the poultry-yard, embryology. Why should psychologists encourage the impression that anything which concerns "human nature" is psychology; that psychology covers the field of "human experience, behavior and personality," or that it is whatever the student of psychology seriously undertakes? What would become of zoology if it professed to compass all of man's varied interests in life, or of physics if it similarly extended its present domain?

The war has shown us how many things beside the concern for his own science or art a trained or skilled man may, when occasion offers, usefully turn his hand to; but we are still tempted to confuse—at least in the case of psychology—the subject and its outside uses, applied science and science applied, the tasks of the science and the man trained by the science applying himself to extra-psychological tasks. The confusion is natural in the great public, which labels but does not define: it is inexcusable in the spokesman or the zealous apologist for the science.

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SCIENTIFIC BOOKS

Outline of Psychology. By WILLIAM MCDOUGALL. New York, Charles Scribner's Sons. 456 pages.

MCDOUGALL's "Outline of Psychology" offers a marked contrast to the numerous psychological texts that have appeared recently in America. Other system-writers, almost without exception, recognize the validity of the physical "cause-and-effect" relation in the realm of mental phenomena. Professor McDougall expressly denies the possibility of interpreting the sequence of mental events as "a mechanical chain of cause and effect," and asserts that the fundamental category of psychology is "purposive striving" (p. vii).

As explained in the preface, the present volume does not attempt to set forth in sequence the principal facts and laws of the science; it is a carefully constructed train of reasoning, designed to demonstrate the truth of the author's teleological concept, which he terms the hormic theory (p. 71). Viewed in this light, rather than as a systematic treatise, there can be no question but that the book fulfills its purpose remarkably well. The fundamental thesis is definitely stated at the outset and the supporting arguments are marshaled point by point throughout the book.

After outlining the alternative theories and indicating the difficulties of the mechanistic position, the author proceeds to examine the characteristics of animal behavior. He cites Jennings's example of the amoeba in pursuit of a smaller amoeba and the latter's ultimate escape to prove that even in the simplest known creatures behavior is essentially purposive. In successive chapters the behavior of insects, lower vertebrates and mammals is examined with the same result. Especial stress is laid on the fact that an instinct is not a mere grouping of reflexes but a unified act which serves to accomplish some definite purpose in the animal's life history.

The transition to human psychology is somewhat marred by a chapter (VII) entitled "Behavior of the natural man," which speculates upon the behavior of an assumed non-social being, "Mowgli," somewhat after the fashion of the eighteenth century social contract literature. This is the only departure from the empirical method. The remainder of the book is taken up with a detailed examination of man's mental activities, such as attention, imagining, emotions, disposition and temperament, and belief, concluding with the growth of intellect in general and the organization of character. Throughout these successive stages the purposive nature of mental activity is emphasized; the organism's behavior is portrayed as a constitutional *striving* to attain an end, dimly foreseen in the lower species, distinctly pictured in the higher human realm. This *conative* tendency is coupled with the *cognitive;* the two together complete "the description of mental activity in its double aspect of knowing and striving" (p. 266).

As already stated, McDougall's work is radically opposed to the general trend of American psychology. Contemporary writers for the most part accept the causal principle in what McDougall would call its mechanistic form. They assume that the activity of

the nervous system, including the brain, is describable in terms of physicochemical processes, and that the principles or modes of mental activity are in some manner closely related to the modes of neural activity. Even the radical behaviorist, in denying the scientific character of the "mental," merely emphasizes the supremacy of "natural law." To McDougall, on the other hand, mental activity belongs to a distinctly different type from inorganic activity. Organic behavior does not follow the resultant of forces—it pictures the future and operates to attain a desired end.

The teleological theory offered in this book is closely related to the vitalistic theory in biology. Each assumes a mode of activity distinct from the strictly causal sequence of events—a factor which somehow guides the flow of energy and determines the outcome. It is precisely at this point that the teleological conception is open to challenge. The arguments of Driesch for an organic entelechy have been seriously questioned by leading biologists. Similarly, Professor McDougall's colleagues will question his teleological interpretation of response. The present volume offers no suggestion as to the *manner* in which the hormic activity works. The author merely states that the end is foreseen and that the activity proceeds till the purpose in view is accomplished. But is this true? Certainly the adult who has endeavored to twitch his ears without prior training finds that the purpose to accomplish this result does *not* attain the appropriate goal, no matter how intense or prolonged the striving. And so with the lower types of behavior. "Instinctive activity," says McDougall, "strives toward a goal, a change of situation of a particular kind, which alone can satisfy the impulse and allay the appetite and unrest of the organism" (p. 119). In pre-Darwinian days the instincts might well have been defined in these teleological terms, but natural selection indicates an alternative explanation —evolution of traits by racial "trial and error"— which seems both intelligible and plausible. Such questions of fact and interpretation will have to be thoroughly threshed out before the real value of McDougall's work can be determined.

Perhaps the weakest point in the present volume is the author's vagueness in defining his fundamental concepts. The reader will ask for a more lucid description of *striving, conation* and *foresight* than is given. There is also throughout the book a certain dogmatic insistence upon the cardinal doctrine of teleology, coupled with an all too frequent use of the adjectival method of refuting opponents. ("Loftily assert," p. 28; "impossible," "obviously absurd," p. 84; "fantastic theories," p. 128; "lofty attitude," p. 194; "the extravagant behaviorist doctrine," p. 289.)

On the other hand, the evidence for non-mechanistic activity is ably presented and deserves careful and unprejudiced study on the part of investigators, to whatever school they may belong. Professor McDougall's formulation of the hormic theory (p. 71–3) raises teleology from metaphysical speculation to a real psychological problem, and his explanation of the nature of free-will (p. 46–8) gives that time-worn theory a new meaning.

Of special interest is the discussion of the seven marks which the author believes distinguish the behavior of organisms from the physicochemical activities of inorganic matter (pp. 44–46, 56). These are: (1) spontaneity of movement; (2) persistence of activity; (3) variation of direction of persistent movements; (4) termination of the activity when a particular change in situation is brought about; (5) preparation for the new situation; (6) improvement in the effectiveness of behavior; and finally (7) the fact that "purposive action is a total reaction of the organism," rather than a specific reflex or group of reflexes. These characteristics, taken together, afford perhaps the best synthetic view of the teleological conception of behavior.

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Historia de la Influencia Extranjera en el desenvolvimiento Educacional y Cientifico de Costa Rica. Por LUIS FELIPE GONZALEZ. Imprenta Nacional, San José de Costa Rica, 1921. 8vo, pp. (6) + XI + 320, 24 plates, each containing four portraits.

THE title of this clearly printed volume accurately describes its contents, which are concerned with the rôles played by various European and American nations in the educational and scientific development of the most liberal and progressive of the Central American republics—Costa Rica. It is a centenary volume, issued in the year when these republics celebrated the hundredth anniversary of their independence of Spain. It is divided into two parts.

The first part comprises eight chapters, 61 pages and, in the words of the author, analyzes the different factors which have determined the national culture during the first two thirds of the century of separate existence.

The universities of Spanish colonial America were those of Mexico, Guatemala, León, Santa Fé de Bogota, Lima and Cordoba. They possessed the same medieval culture peculiar to those of the mother country. Essentially conservative, they gave preeminence to ecclesiastical studies and scholastic philosophy, that mistress of theocratic Spain, with her bookish and memorizing systems, narrowness of spirit, filled with preoccupation and routine that offered not the least impulse to scientific investigation.

Their knowledge crystalized in traditional formulae, with essentially mnemotechnical methods of the purest scholasticism, with the order of cyclical teaching and the dogmatism of the peninsular cloisters. Under such conditions the Hispano-American university lived without the stimulus of philosophic and scientific culture which culminated in the teaching institutions of other countries, due to European investigation.

In the early years of the 19th century members of influential families of Costa Rica attended the University of León (Nicaragua), as the nearest institution of higher learning, and through them and other graduates who went to Costa Rica to take part in the political organization of the latter country, after its independence was proclaimed in September, 1921, the Nicaraguan institution exercised great influence on the intellectual and educational development of the neighbor to the south. One of the Leonese alumni was Rafael Francisco Osejo, called in 1814 by the municipality of San José (Costa Rica) to direct the House of Teaching of St. Thomas (*Casa de Ensenanza de Santo Tomas*). Here in 1825, or soon thereafter, modern foreign languages, English and French, were for the first time taught in Costa Rica. Professor Osejo, in his character as a deputy in the Ordinary Assembly, was the author of the first law of public instruction in Costa Rica, promulgated in May, 1832, according to which the municipal bodies were required to oblige fathers of families to procure for their children between the ages of eight and fourteen years instruction in Christian doctrine, reading, writing and numeration, and imposing a fine of 3 pesos per year on those who did not fulfil this obligation.

From about 1840 the influence of the University of San Carlos at Guatemala, with the more liberal tendencies in its organization, began to supplant that of San Ramón de León, especially in law and in medicine.

Immigration from Europe, South America and the other Central American countries followed the establishment of independence and tended to increase the elements of and desire for culture. The first Costa Rican youth to seek an education in Europe, José Maria Montealegre, left his native land in 1826, at the age of eleven, passed through High Gate School in London, obtained the medical degree in Edinburgh and returned home early in 1840. Not until 1863 did Costa Ricans come to the United States to study medicine.

The increasing production of coffee, the establishment of a regular port of call at Puntarenas by steamships of the Pacific Mail in 1856, the arrival and prolonged residence of distinguished German engineers and scientific men like Rohrmoser, Frantzius and Hoffmann, constituted additional factors in the increasing enterprise and development of the country.

In 1848–1850, treaties of amity and commerce were made with Great Britain, France, the Hanseatic cities, Spain and the United States, and accredited representatives of these countries soon began to function in Costa Rica.

The influence of the other Central American states declined with these events in proportion as that of Europe and the United States increased. Nevertheless, the foundation of the Liceo de Costa Rica at San José in 1864 was largely due to Maximo Jerez, a native of León, proscribed by his own country and who, as a result, dwelt in Costa Rica from 1863 to 1868.

A Guatemalan, Felipe Molina, was the first minister plenipotentiary from Costa Rica to the United States, dying in Washington February 1, 1855, while discharging that function. He was the author of the first historical and geographical sketch of Costa Rica, a work which did good service in acquainting foreigners with the possibilities and beauties of the country and which long served as a text-book in the schools and colleges of Costa Rica itself.

A railroad from the Atlantic port of Limon to the capital, San José, was completed in 1891, while that on the Pacific side halted between Orotina and Esparta for some time and was finally extended to Puntarenas in 1910.

All of the movements of which the events mentioned above were the visible signs are duly considered with reference to the intellectual development of Costa Rica.

Beginning in 1869 the Costa Rican government entered into contracts with teachers in various European countries to instruct the youth of the republic. The first of these instructors was Professor Valeriano Fernandez Ferraz, who had occupied chairs in Greek and in Arabic in the universities of Seville and Madrid, and who on reaching Costa Rica organized, and for three years directed, the College of San Luis Gonzaga at Cartago. He was followed to Costa Rica by his two brothers, one of whom, Juan Fernandez Ferraz, became Director of the Museo Nacional in 1898 and served the state in many other capacities.

Others who went to Costa Rica under similar arrangements were the botanist Helmut Polakowsky (1875), and a notable group of young Swiss scientific men, Paul Biolley (1886), Henri Pittier (1887), Gustave Michaud and Jean Rudin (1889), all of whom remained for many years in the country and added greatly to the development of science by teaching and by research.

The second and larger part of the book traces the influence derived from each country to which Costa

Rica has been indebted for her educational and scientific life. One or more chapters are devoted to Germany, Argentina, Belgium, Colombia, Cuba, Chile, Spain, the United States, France, England, Italy, Mexico and Switzerland. The individuals of these countries who have visited and studied in Costa Rica, or who have described her natural productions, are discussed biographically and lists of their publications relating to the country are given. Pedagogical theories and methods proceeding from these different sources are considered with respect to Costa Rican schools and teaching. Four chapters (nearly 100 pages) are devoted to the United States, wherein 103 authors and travelers are named or discussed. The data on books and publications given in this volume constitute a fairly complete bibliography of foreign authors on Costa Rican pedagogy and natural science.

Senor Gonzalez's history is surely of great value to Americanists, Pan-Americans, naturalists and historians of science.

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SPECIAL ARTICLES

NOTES BY N. M. STEVENS ON CHROMOSOMES OF THE DOMESTIC CHICKEN

RECENTLY, in looking over a file of old research notes I came across a package of rough notes and drawings by Miss Stevens on the chromosomes of the domestic chicken, which had been given to me after her death. She had been working at this problem at odd times at the same time that Dr. Pearl and I had in 1914. We had sent her adult testis material from the Maine Agricultural Station, and she had also worked on embryos. The present interest in these notes lies in their bearing on T. S. Painter's paper on Reptilian Spermatogenesis (*Jour. Exp. Zool.*, 34, 281–327). Painter says that one object of his study was "to determine what light a study of reptilian spermatogenesis would throw on the spermatogenesis of birds since reptiles and birds are closely related phylogenetically." No one as yet has published any satisfactory results on bird chromosomes. The outstanding feature in the lizard spermatogenesis seems to be the arrangement of the chromosomes in the equatorial plate, a definite number of large chromosomes in a ring around a center group of small chromosomes, the number of which is sometimes difficult to determine. Miss Stevens's drawings show equatorial plates which exhibit a striking resemblance to those drawn from the lizard by Painter. She suggests that there may be a nebula of small chromosomes at the center of the group which clump readily in poor fixation and therefore have often been taken for several large chromosomes.

Her drawings show 12 large chromosomes forming the outer circle in the spermatogonia and usually 6 (occasionally 5 or 7) in the spermatocyte. The number of small chromosomes figured in the center varies, being usually 12 or 14 in the spermatocyte where they are of course easier to identify than in the spermatogonium. I include copies of six of her drawings. They were camera lucida drawings, but had not been finished as these were only fragmentary notes at the beginning of a study. Figures 1 and 2 are spermatogonia, each with 6 pairs of large chromosomes and a mass of small chromosomes. Figure 1 was marked "question as to how many small ones—too thick together." Figure 2 was marked "all rather mixed in the center." Figures 3 and 4 are prophases of the first spermatocyte division. Each shows 6 large chromosomes. Figure 3 has 14 small chromosomes, while Figure 4 has 16. Figures 5 and 6 are equatorial plates of the first spermatocyte division. Here we find 6 large chromosomes; in Figure 5, 14 small, while in Figure 6 there seem to be only 12 small. Some other drawings bear the following comments

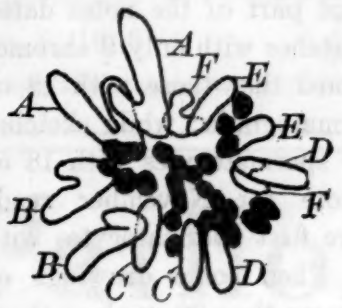

Fig. 1

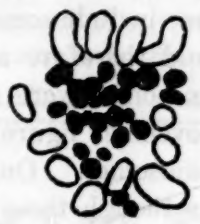
Fig. 2

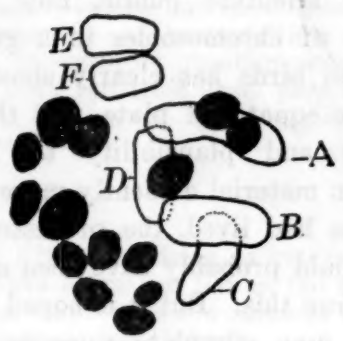

Fig. 3

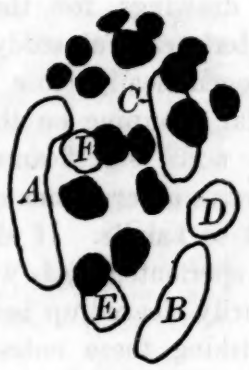

Fig. 4

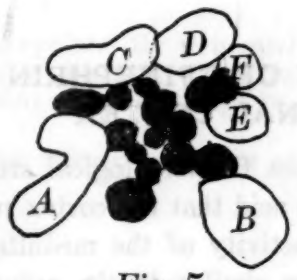

Fig. 5

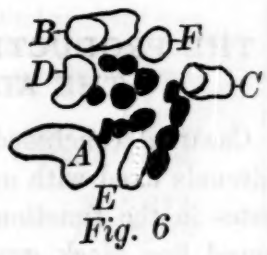

Fig. 6

which show her uncertainty as to the number of small chromosomes: "Apparently 18, but number of small ones always uncertain"; "large ones all clear, small ones may be more"; "impossible to tell how many small ones."

It may be of interest that part of the notes dated September include some sketches with only 9 chromosomes, and therefore assumed that those with 18 or 20 chromosomes were spermatogonia; while sketches dated November figure the spermatocytes with 18 or 20 chromosomes. One note for November reads "looks as though these were first spermatocytes with about 18 chromosomes." Then come drawings of spermatogonia with many more than 20, such as those copied here.

It has seemed worth commenting on these notes and drawings for the scientific public, now that Painter's careful study of chromosomes in a group phylogenetically close to birds has clearly shown a similar grouping on the equatorial plate, and therefore adds significance and plausibility to Miss Stevens's observations on material evidently more difficult to handle. If she had lived, the processes of bird spermatogenesis would probably have been satisfactorily cleared up before this. But it is hoped that publishing these notes may stimulate some one to continue work on this material and try to settle the matter.

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THE PRODUCTION OF EPINEPHRIN BY THE ADRENAL CORTEX

CRAMER[1] concluded from the histological study of adrenals fixed with osmic acid that the cortex participates in the functional activity of the medulla. He found fine black granules similar to the epinephrin granules of the medulla.

We have obtained further evidence that epinephrin is produced by the cortex. The adrenal of a cat recently killed was carefully removed and then frozen with CO_2. Some of the outer portion of the cortex was sliced away with a razor. This material gave a positive test for epinephrin by the Folin, Cannon and Denis[2] reaction. It likewise caused inhibition of a piece of kitten's intestine contracting in Ringer's solution.

The cortex of an adrenal, the medulla of which had been completely destroyed by cautery thirty days previously, gave a positive test for epinephrin by the Folin, Cannon and Denis method. The destruction of the interior of the gland was so thorough that only a thin shell of live cortex remained. Cortex of another adrenal prepared in a similar fashion gave a good inhibition of contracting intestine. By the use of the exercise test[3] we have also obtained an indication of epinephrin production by the cortex. One iris had been made sensitive to epinephrin by the removal of the superior cervical ganglion on that side. One adrenal had been removed and the medulla of the other had been thoroughly destroyed by cautery. After complete recovery, exercise in the treadmill caused dilatation of the sensitive pupil.

Whenever there seemed to be a possibility of the presence of good medulla we have studied microscopically sections of the gland fixed with formaldehyde and potassium bichromate.

Finally, we have used the completely denervated pupil[4] in order to determine whether the cortex produces epinephrin. The excitement caused by shutting off the air from the lungs for 40 seconds rarely fails to produce an increased secretion from the adrenals. Moreover, it produces perhaps the most marked effect among stimuli which are harmless. Our method has been to destroy the medulla of one adrenal by electric cautery several days before the experiment. The reaction to shutting off the air from the lungs was observed, the denervated pupil being measured by a smaller caliper square. The good adrenal was then removed. After recovery from the anesthetic the pupil response to shutting off air from the lungs was again determined. The cauterized adrenal was next removed, a final test of the denervated pupil being made after recovery from anesthesia. The cauterized adrenal was fixed and examined microscopically for the presence of medulla, the whole gland being sectioned (sections of 25μ). Approximately every fifth and sixth sections were saved, the others being discarded.

To be more certain of medullary destruction much of the cortex was destroyed.

Experiments on fourteen cats were completed. A small portion of the medulla remained in five; medullary tissue was absent in nine; but four of these had the cortex almost completely destroyed. The five cats possessing healthy cortex and no medulla in the cauterized adrenal gave good denervated pupil reactions to shutting off the air after removal of the uncauterized adrenal. After removal of the cauterized adrenal the denervated pupil gave a much smaller reaction or no response at all to a similar test.

All of our evidence indicates that the adrenal cortex produces epinephrin.

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[1] Cramer, W., *J. Physiol.*, 1918, LII, viii–x, xiii–xv.

[2] Folin, O., Cannon, W. B. and Denis, W., *J. Biol. Chem.*, 1913, XIII, 477.

[3] Hartman, Waite and Powell, *Am. J. Physiol.*, 1922, LXII, 225.

[4] Hartman, McCordock and Loder, *Am. J. Physiol.*, 1923, LXIV, 1.